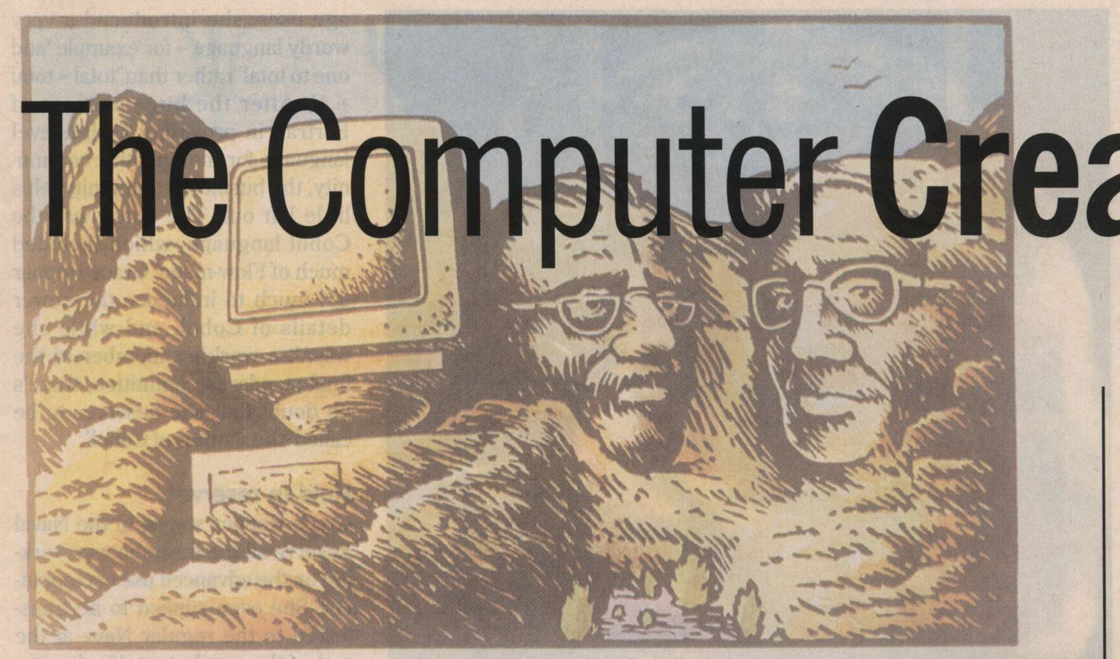


The Computer Creators

Mike James follows the long career of Grace Hopper, programming pioneer and man of the year, 1969

The history of computer hardware invention is mostly a male-oriented affair. That isn't surprising, given the time at which early computers were developed and the fact that they had more to do with heavy engineering than logic. However, when it comes to software the picture is a little different. It's generally acknowledged that the first programmer was Ada, Countess of Lovelace (*Computer Creators*, issue 52), but Ada was just the first in a long line of dedicated women programmers. After Ada, the most famous, important and colourful member of this army (or should that be navy?) of female software experts is without doubt Rear Admiral Grace Brewster Murray Hopper. She was responsible not only for the development of Cobol, but for continuous pressure within the industry to make computers and computing more accessible.

File card: Grace Brewster Murray Hopper

Grace Brewster Murray Hopper	
Lived:	1906-1992
Country:	USA
Specialism:	Software
Theories:	Programming languages
Products:	Cobol
Companies:	None

Grace Hopper certainly suffered, at least at first, from the disadvantage of being a woman with an interest in technology. It's reported that as a child she dismantled an alarm clock to see how it worked. To find out how to put it back together again, she dismantled another – and so on until there were seven alarm clocks in pieces. Her parents let her off, taking it as a sign of an inquisitive mind, although if she had been a boy, even this small sign of engineering interest would no doubt have been leapt upon and nurtured.

She did well at mathematics at school, especially geometry, which was treated more seriously in those days. In 1924 Grace went to Vassar College, New York, to study maths, physics and engineering. She moved to Yale in 1928 to gain a masters degree and then a doctorate in maths and mathematical physics. The love of geometry stayed with her, as is evidenced by the contents of her thesis, *A New Criterion for Reducibility of Algebraic Equations*, which she proved using geometrical arguments which were already very much out of fashion at the time!

At the time, even if a woman was as gifted a mathematician as Grace Hopper she could only look forward to teaching maths at no more than high-school level – women weren't expected to do any more. Grace was different. In 1931, she started to work her way up through the Vassar teaching hierarchy – first as an instructor, then as an assistant professor and finally as an associated professor. Just before this she married Vincent Hopper. They divorced in 1945 – an event which left her free to pursue her contributions to computing without having to fit into the stereotype of the time.

In the Navy

After the US entered the Second World War, Grace Hopper joined the US Naval Reserve, following in the path of her grandfather, a Rear Admiral. The Navy immediately saw how valuable Hopper would be. After some basic training, she was assigned to the Bureau of Ships Computation project at Harvard. Although she had never been interested in computers, she found herself at one of the foremost centres of computer development. At Harvard, Howard Aiken had built the Mark I – a huge and slow electromechanical computer which could manage three additions every second. When Hopper arrived, Aiken wanted to know where she had been for the past few months. He wasn't at all pleased that she had been wasting her time, and subsequently told the Navy to skip the rest of her basic training because there was so much work to do!

Lieutenant Hopper was greeted by a book of instruction codes and set to the task of working out the interpolation coefficients for the inverse tangent function. At the time, computers were first and foremost big printing calculators, and the production of numerical tables occupied most of their functioning time. Hopper would do much to expand this rôle to the more modern idea that a computer is a manipulator of symbols, but this important work was to come later. Her time with Aiken served as her basic training in computing. She learned to program. She learned the value of subroutines and cooperation. She was exposed to the writings of Babbage (see *Computer Creators*, issue 57), and she invented the term 'bug'.

In fact, whether Hopper really was the first to coin the term 'bug' is an open question, but her version of the story is at least fun. The Mark I was acting up and giving incorrect results. An internal examination located the faulty ➧

relay and there, jammed between the contacts, was a moth – beaten to death by the rapid opening and closing of the relay. The moth was removed and taped into the machine's log book with the note: "First actual bug found" – clearly, Hopper and her colleagues had already long been referring to programming errors as 'bugs'. After this, Aiken would come in and say, "Are you making any numbers?" and they would reply that they were "debugging the machine" – a perennial programmer's excuse ever since!

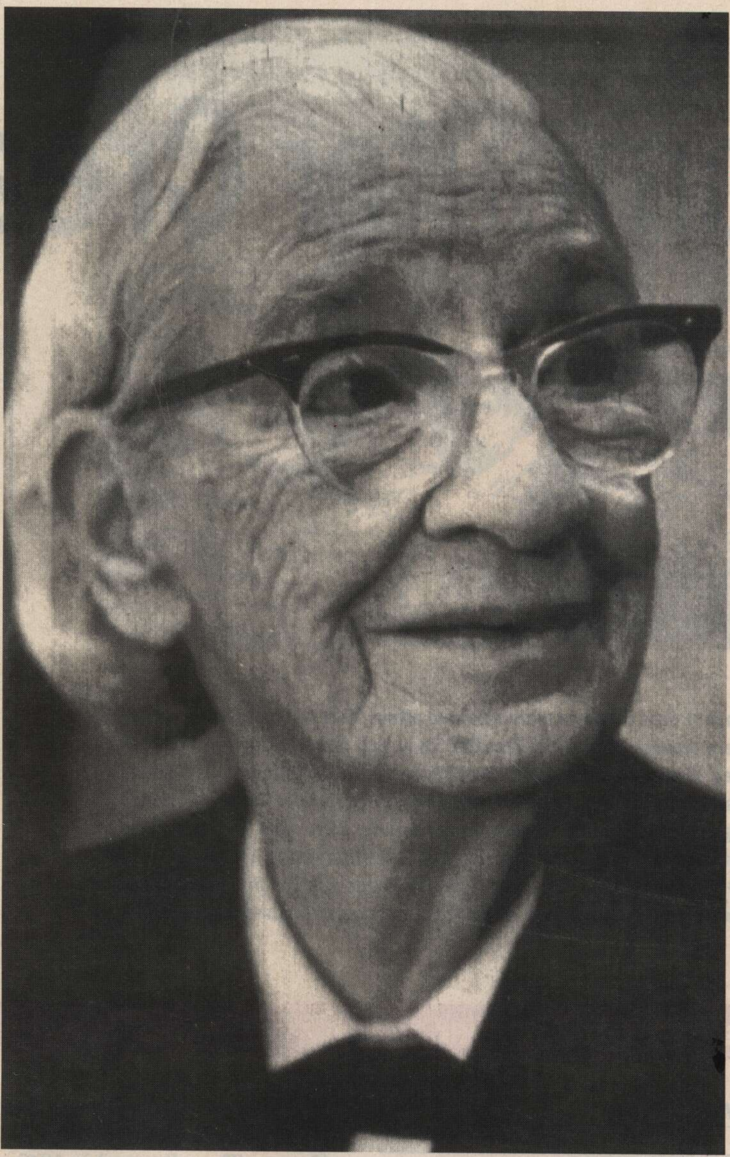
It's clear that Aiken was a hard task master, because Hopper also reported that, like generations of programmers to come, she spent many long nights working hard to make something work properly. It's also worth mentioning that it was her job to write the first manual for the Mark I – a job that Aiken gave her with the words "You're in the Navy now" to dispel any doubts she might have had about completing the task.

Forward thinking

After the war, Hopper spent some time programming actuarial tables for the Prudential and then teaching at Harvard. Her next important move was to the Eckert-Mauchly Corporation, which was nearing completion of the Univac. Before that machine was available, she programmed the Binac – a small binary machine that was built in secret for the Snark Missile project. This used an octal representation for its op codes, and Hopper quickly learned to think in octal – even to the extent of mistakenly adding up her bank balance that way!

It was at this time that she seems to have realised the computer was a symbol manipulator rather than just a big calculator. This may have been due to her exposure to some of Babbage's more philosophical ideas, or simply because the machines were becoming more capable. Even if it was a natural progression, it's clear that most other people – programmers included – tended not to share this now obvious viewpoint.

At first she thought about ways of making machines easier to use by creating higher-level languages. This again seems like an obvious move, but at the time there were no compilers in existence, let alone compilers that could produce efficient code. In 1952, Hopper and her team at Remington wrote the A-0 compiler, almost just to prove that it could be done. To make it all work, they had to invent many of the fundamental techniques of translation. For example, Hopper solved the problem of forward references by using a fixed jump area where the address of routines could be stored when they were discovered later in the program's text. She claimed the idea came from her days playing women's basketball where the forward pass was a well-used strategy. This same technique is still used today in all sorts of ways – the *Windows* Think relocation block for example – and the programmers who use it always think it's very clever and sophisticated!



Grace Hopper, the mother of all high-level programmers

The belief that the computer was just a number cruncher and couldn't be used to translate or work with general symbols was so widespread that A-0 wasn't perceived as being particularly important. In another attempt to widen horizons, Hopper wrote the first symbolic differentiator – a calculus program – and invited people to bring her problems for solution. One poor man had been working for six months on the derivatives of a particularly horrible function – the machine spat out the first fifteen derivatives in 18 minutes. The man refused to believe that there wasn't a human hiding somewhere in the system! At a more trivial level, she demonstrated that a compiler could translate programs written in French and German into machine code. The company executives were shocked that a machine built in the USA could do anything in a foreign language.

The tide slowly turned in her favour and at last she was given the chance to put together a compiler for a large language – the B-0 compiler which, in 1957, became Flow-matic. The language was targetted at business use, and since Hopper felt that arithmetic expressions were too complicated for the average user, she introduced a very wordy language – for example 'add one to total' rather than 'total = total + 1'. After the huge success of Fortran in providing a high-level language for the scientific community, the business community felt a little left out. The result was the Cobol language, which included much of Flow-matic. Grace Hopper did much to influence the newer details of Cobol, and while she wasn't a working member of the final standards committee, there's no doubt that she deserves to be called 'the mother of Cobol'.

Held in reserve

Grace Hopper stayed in the Naval Reserve all the time she was working on the advanced use of computers. She even applied to be transferred to the regular Navy at the end of the war but, at 40, she was deemed too old. In 1966 Hopper retired at the rank of Commander, but the Navy still needed her, and seven months later she was asked to take on the job of standardising the Navy's use of languages. She returned to active duty at 60 and was promoted to Captain. In 1969, the Data Processing Management Association selected her as their first 'man' of the year – something that I'm sure must have amused her, as she held the view that women were in general better programmers than men!

Hopper was promoted to the rank of Commodore in a ceremony at the White House in 1983, and her later years brought the recognition that was denied to so many other early computer pioneers. In 1971, the Grace Murray Hopper Award for young computer personnel was established by the ACM (Association for Computing Machinery).

In 1985 she was promoted to Rear Admiral – the same rank as had been held by her grandfather – and the following year she retired for the last time. At her retirement ceremony, she reminded the assembled sailors that she had been told at forty she was too old for the Navy, yet she had remained in uniform for the subsequent 40 years. All through her career with the Navy she had acted as a publicist – she estimated that she gave 200 lectures per year. And her work wasn't over. She may have retired from the Navy at 80, but she started a new career with DEC in public relations. Grace Hopper died in 1992, certainly the longest-serving computer enthusiast. ■